

Original Research Article

Efficacy of antiglide plate in vertical shear fractures of medial malleolus due to supination adduction injury around ankle: a prospective clinical study

Kamal Kumar Aora¹, Rajesh Kapila¹, Priti Chaudhary²,
Raminder Singh^{1*}, Sarika Kapila³

¹Department of Orthopaedics, Amritsar, Punjab, India

²Department of Anatomy, AIIMS, Bathinda, Punjab, India

³SGRD Institute of Dental Sciences, Amritsar, Punjab, India

Received: 15 October 2021

Revised: 09 November 2021

Accepted: 16 November 2021

*Correspondence:

Dr. Raminder Singh,

E-mail: kka1967@rediffmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Ankle fractures represent 10% of all fractures with an incidence of around 137/100000 population per year, making these the second most common lower limb fractures after hip fractures. Increasing age, obesity and alcohol abuse are the major causal factors for the fractures around the ankle joint. These are typically low energy injuries with the majority occurring due to simple falls or sport. The aim was to open reduction and internal fixation of these with an antiglide plate.

Methods: The present prospective study was carried out at government medical college Amritsar, Punjab in 25 patients of same demographic profile, March 2018 to December 2020 after having the clearance of ethical committee. All the patients after careful assessment of the injury both clinically (pain, swelling, deformity, any blisters) and radiologically (type of fracture, that is, vertical shear fracture of medial malleolus) were internally fixed under spinal anesthesia, with an antiglide plate after reduction of the fracture fragments.

Results: The results were assessed accordance with Olerud-Molander ankle score (OMAS). We achieved excellent to good results with an average OMAS score of 80/100 in the present study.

Conclusions: The open reduction and internal fixation of vertical shear fractures of medial malleolus with an antiglide plate is an effective way of management of these fractures. It ensures maximum stability and more so safeguards against loss of reduction or the implant failure under axial loading and at the same time ensures the timely union of such fractures without any significant complications.

Keywords: Ankle fractures, Open reduction and internal fixation, OMAS

INTRODUCTION

Supination-adduction injury is one subtype as per Lauge-Hansen classification which causes a vertical fracture of the medial malleolus. It is different from the usual transverse fracture of the medial malleolus due to pronation external rotation or pronation abduction injuries, which is usually managed by either tension band

wiring or by malleolar screws. The vertical fracture of the medial malleolus may be managed by open reduction and internal fixation with two parallel screws perpendicular to the fracture line or by an antiglide (AG) plate put on the medial surface of tibia.

The present study was done to confirm the efficacy of AG plate over open reduction and internal fixation of

these fractures by two parallel subchondral screws perpendicular to the fracture line.

Ankle fractures represent 10% of all fractures with an incidence of around 137/100000 population per year, making these the second most common lower limb fractures after hip fractures.¹⁻³

The mean age at injury was 45 years, significantly older than that of patients sustaining isolated ankle sprains.^{2,4} Both injuries have a bimodal distribution, with the peak incidences of ankle injuries in younger men and older women and a 50 year age gap between peaks, these were typically low energy injuries with the majority occurring due to simple falls or sport.^{2,5} Even open ankle fractures were predominantly low-energy injuries caused by simple falls with the highest incidence in elderly women.⁶ Although ankle fractures were not associated with systemic low bone mineral density per se, the micro architecture of the trabecular bone in the distal tibia of elderly patients with ankle fractures was abnormal and depleted.^{7,8} The bone stiffness was reduced, compared with uninjured controls, suggesting that these injuries should be considered to be true osteoporotic fractures. Increasing age, obesity and alcohol abuse were the major causal factors for the fractures around the ankle joint.⁸⁻¹⁰

In past Pott 1758, Danis 1949 and Weber 1966 orthopaedic trauma association have classified these injuries based upon the number of malleoli fractured, site of lateral malleolus fracture and associated soft tissue injuries respectively.¹¹⁻¹³

The aim of present study was to assess the clinical and radiological outcome of fixation of medial malleolar fracture by open reduction and internal fixation of these with an AG plate.

Hypothesis

The present study was based on the hypothesis that the fixation of vertical shear fractures of medial malleolus with an AG plates provides a stiffer, stable construct with minimal chances of implant failure under axial loading when compared to fixation with screws alone.

METHODS

The present prospective study was carried out at government medical college, Amritsar, Punjab in 25 patients of same demographic profile, after obtaining the permission of ethical committee (letter no. BFUHS/2K21p-TH/5547) and having a written consent of the patients for their participation in the study between March 2018 to June 2020 in the department of orthopaedics.

Clinical examination was done on admission, begun with inspection for deformity, bruising, blistering, skin integrity and color. A careful palpation of the limb then

was done at the fibular head and progressed sequentially down the lateral aspect of the leg to the lateral malleolus for any fibular/lateral malleolar fracture and the soft tissues anterior and posterior to it before moving medially across the ankle joint to the medial malleolus and its adjacent soft tissue structures. A distal neurovascular assessment included assessment of temperature and capillary refill and movement at tarso-metatarsal and metatarso-phalangeal joints. X-ray was done keeping Ottawa ankle rules in mind.¹⁴ Three standard radiographs, an anteroposterior (AP), a lateral and a mortise projection of the ankle were done as a routine. Tenderness of the proximal fibula if any was investigated with a full-length radiograph of the leg. A mortise view of the ankle (taken in 15 degrees of internal rotation) was extremely helpful in assessing the lateral aspect of the ankle, often poorly seen on the AP view because of the frustal shape of the talus and consequent overlap of the tibia, fibula and talus.

Inclusion criteria

Patients aged between 25-60 years of age (skeletally matured patients as the patients who were admitted with this type of injury were in this age group); patients with closed fractures (supination adduction subtype of Lauge-Hansen classification system of ankle fractures based upon causative mechanism of injury), both unimalleolar and bimalleolar fractures were included in present study. Patients with fresh fractures (acute injuries of less than a week duration) were also included.

Exclusion criteria

Patients with intra-articular fractures of distal tibia, (plafond fractures); pathological fractures (fractures due to severe osteoporosis, metastatic fractures) patients with systemic disorder (COPD, hypertension, tuberculosis, uncontrolled diabetes mellitus type II (FBS >110 mg%) even with oral (gliptins)/injectable hypoglycaemic agents (insulin); patients with psychological disorders, unable to maintain personal hygiene (due to possible non-compliance of postoperative instructions; patients with coagulation abnormality (due to possible increased risk of bleeding post operatively at wound site); patients on steroid therapy; patients with deranged renal function tests (blood urea >40 mg%)/liver function tests (SGOT >40 units per litre, SGPT >56 units per litre); patients with advanced peripheral vascular disease with occlusion of vessels at extremities secondary to type II diabetes mellitus, Berger's disease; and patients with other confounding factors (>65 years of age, compliance, monophasic or biphasic circulation in tibial vessels), varicose ulcers, alcoholism and smoking were excluded from the study.

All the patients operated under spinal anaesthesia (bupivacaine) with a preoperative broad-spectrum antibiotic (cefuroxime 1.2 gm) shot before surgery. The patient was placed supine on the operating table and the fracture site was approached through a medial linear

incision, open reduction of the fracture site was done and was fixed with an AG plate with insertion of the screws perpendicular to the fracture at subchondral level. Reduction checked with the help of c-arm imaging and wound was closed in layers after securing haemostasis. Antiseptic dressing was done and a posterior POP splint was applied. Patients were kept on broad-spectrum intravenous antibiotics (cefuroxime+amikacin) for five days postoperatively to prevent any postoperative superficial and/or deep infection. Check dressing was done on third postoperative day and the patient was stitched out on 12th postoperative day. Average stay of the patient in the hospital was seven days postoperatively for subsidence of postoperative edema and also to have a check in increase of the biochemical markers if any.

Patients were followed up in the outpatient department both clinically and radiological signs of bony union at three weeks, six weeks, 12 weeks and finally after six months of the surgery/till the union occurred at the fracture site. Clinical signs of union were taken as no pain, warmth or redness at the fracture site and unrestricted weight bearing at follow up visits.

Radiological appearance of callus in three cortices around the fracture, obliteration of fracture line, homogenous bone structure, trabecular and cortical continuity all predicted radiological union.

The final results were assessed in accordance with OMAS calculated at every follow up visit, based upon pain, swelling, stiffness, climbing up the stairs, running, jumping, squatting, use of supports and overall activity level.

The IBM SPSS software package version 20.0 (Armonk, NY: IBM Corp) was used for data analysis. Number and percent were used to describe qualitative data. Variables normality of distribution was verified using the Kolmogorov-Smirnov, Shapiro and D'Agostino tests. Range (minimum and maximum), mean, standard deviation used to describe quantitative data. Significance of the results was judged at the 5% level. P value was statistically significant at $p \leq 0.05$.

Table 2: Results showing age, sex, side, mode, hospital stay, time of union and weight bearing, complications.

Parameters	N (%)	
Age (in years)	21-30	2 (8)
	31-40	3 (12)
	41-50	16 (64)
	51-60	4 (16)
Sex	Male	21 (84)
	Female	4 (16)
Side	Right	20 (80)
	Left	5 (20)
Associated injuries	Fracture fibula	8 (32)
	Bimalleolar fracture	3 (12)
Mode of injury	Road side accidents	2 (8)

Continued.

RESULTS

All the 25 patients reported for follow up post operatively. Average stay in hospital from time of operation to discharge was 19 days (one week in the hospital for subsidence of postoperative edema and also to have a check in increase of the biochemical markers if any) on the average (10-28 days). Partial weight bearing commenced at 5.44 weeks on the average and full weight bearing on the average after 10.48 weeks of operation. Superficial infections were observed in three (12%) treated with intravenous antibiotics and deep infection in two (8%) which responded to suppression antibiotics until the required surgery for removal of the hardware and/or sequential debridement of the wound. One case (4%) had loss of fixation mainly because of poor bone stock due to comminution in the posteromedial cortex of medial malleolus at the fracture site and lack of compliance due to financial constraints to follow the postoperative instructions. One of the late complications was the symptomatic hardware in 5 (20%) and required its removal. Radiological union was achieved in about 12.55 weeks (12 weeks to 16 weeks) in 22 (88%) cases while three cases (12%), it took more than 16 weeks to unite. Full range of ankle movement returned in all cases after about 5 weeks of active movements of ankle. Mean length of time before return to work in patients with vertical medial malleolar fracture treated by AG plating in this series after operation was 12 weeks. There was no valgus/varus angulation, callusing (spell check) of toes, shortening, fat embolism, bending or breakage of AG plate in any case.

Table 1: Ottawa ankle rules for X-rays of the ankle injury.

S. no.	Ottawa ankle rules
	Pain exists near one or both of the malleoli +
1.	Age >55 years old
2.	Inability to bear weight
3.	Bone tenderness over the posterior edge or the tip of either malleolus

Parameters		N (%)
	Direct trauma	3 (12)
	Fall	20 (80)
Stay in hospital	Seven days	20 (80)
	Seven to ten days	3 (12)
	More than ten days	2 (8)
Weight bearing		
Partial weight bearing	10 weeks	20 (80)
Full weight bearing	16 weeks	20 (80)
Time of union	12-16 weeks	22 (88)
	More than 16 weeks	3 (12)
Functional results	Excellent	18 (72)
	Good	5 (20)
	Fair	2 (8)
Complications	Superficial infection	3 (12%)
	Deep infection	2 (8)
	Loss of fixation	1 (4)
	Symptomatic hardware	5 (20)

Table 3: OMAS to assess the final post operative functional score around the ankle joint.

Parameters	Degrees	Score
Pain	None	25
	While walking on uneven surface	20
	While walking on even surface outdoors	10
	While walking indoors	5
	Constant and severe	0
Stiffness	None	10
	Present	0
Swelling	None	10
	Only in evening	5
	Constant	0
Stairs	No problems	10
	Climbing impaired	0
	Not possible	0
Running	Possible	3
	Impossible	0
Jumping	Possible	3
	Impossible	0
Squatting	No problems	5
	Impossible	0
Supports	None	10
	Taping, wrapping,	5
	Stick or crutch	0
Work (activity level)	Same as before injury	20
	Loss of tempo	15
	Change to simple job/part time work	10
	Severely impaired work capacity	0
Total score		100

Table 4: Values of OMAS at twenty-four weeks (n=25 patients).

Parameters	At 24 weeks		P value
	Number (N)	Percentage (%)	
Pain	3	12	<0.001
Stiffness	2	8	

Continued.

Parameters	At 24 weeks		P value
Swelling	2	8	
Stair climbing	5	20	
Running	3	12	
Jumping	1	4	
Squatting	2	8	
Supports	1	4	
Work (activity level)	90 percent of the normal activity		
Total score	90		

OMAS=Olerud-Molander ankle score; Data presented as mean standard deviation; #p value was taken to assess the significance of the findings.

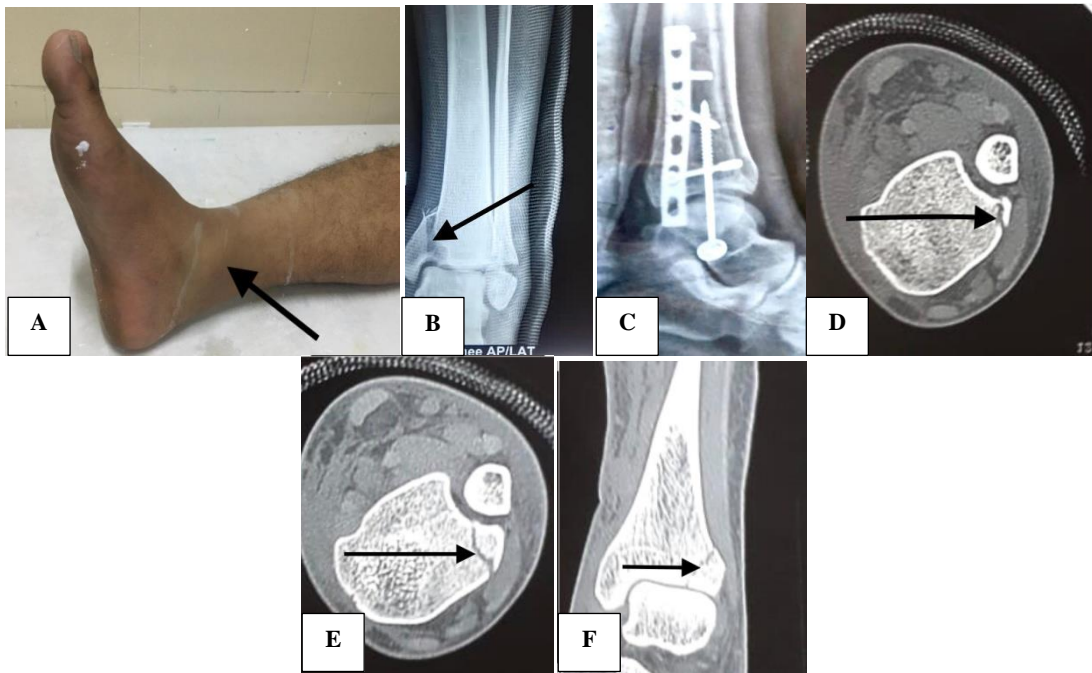


Figure 1: Clinical presentation, pre and post operative X-ray and CT scan of the patient; case 1 (arrows showing the site and kind of fracture); (A) clinical presentation; (B) preoperative X-ray; (C) postoperative X-ray; (D-F) preoperative CT scan of the patient.



Figure 2: Case 2; (A) clinical presentation; (B) preoperative X-ray; postoperative X-ray.

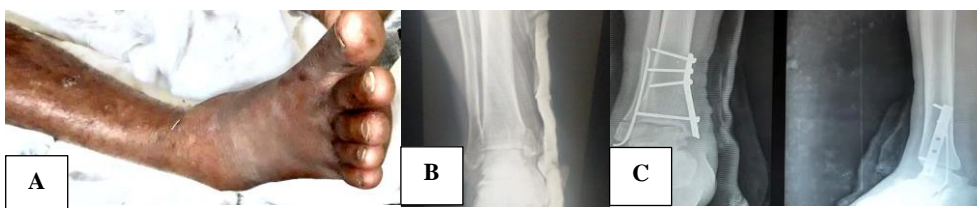


Figure 3: Case 3; (A) clinical presentation; (B) preoperative X-ray; (C) postoperative X-ray.

DISCUSSION

The ankle fracture was the most common fracture second to hip fracture by its incidence. It was more common in elderly postmenopausal females because of trivial trauma, due to poor bone stock.

Pott as early as in 1758, classified ankle fractures based on anatomy, injury mechanics or stability and the number of fractured malleoli as unimalleolar, bimalleolar or trimalleolar, based on the isolated/combined fractures of the lateral, medial and posterior malleoli.

Danis, later modified by Weber described the injury based on the location of the lateral malleolar fracture and classified fractures as A, B or C with a fracture below, at the level of or above the syndesmosis respectively.^{11,12}

Further work on the Danis-Weber system by the AO/ASIF group led to the development of the AO classification of ankle fractures (also been adopted by the orthopedic trauma association (OTA); with a total of 27 different subtypes describing injury to the bony and soft tissue structures of the ankle.¹³

Lauge-Hansen proposed a classification system based upon causative mechanism of injury in 1950 following cadaveric investigations, with two words.¹⁵ The first word described the position of the foot at the time of fracture and the second denoted the deforming force at the ankle, postulating four types of injury, that is, supination external rotation (SER) injury, pronation external rotation (PER) injury, supination adduction (SAD) injury, pronation abduction (PAB) injury. The less common supination adduction injury mechanism has two stages. Initially, due to adduction force in a supinated foot, there was strain on the tibio-fibular ligament and eventually, if there was sustained deforming force, it led to transverse fracture of fibula to end with an impacted/shear vertical medial malleolar fracture. It essentially needed open reduction and stable fixation of medial malleolar fracture along with ORIF of lateral malleolar fracture. These fractures were treated with either lag screws, postero-medial buttress plating and neutralization plates with screws or with AG plates. Despite this cornucopia of fixation methods, the optimal technique and pattern of the internal fixation used for fixation of a vertical shear fracture of the medial malleolus remains ill defined.

Zhao et al did a comparative study on screw or buttress plate for fixation of supination-adduction type-II medial malleolar fracture and concluded that for patients with supination-adduction type-II medial malleolar fracture, the angle between fracture line and tibial axial line was too small to be fixed firmly with simple screws fixation, with a relatively higher failure rate.¹⁶ A buttress plate fixation can reach rigid fixation and has better functional outcomes. The present study had no case of secondary osteoarthritis at ankle joint, also no case of non-union,

compartment syndrome or painful neuroma observed in the present study.

Zhang et al did a COHORT study on path anatomy and clinical outcomes following operative treatment of supination adduction type II medial malleolus fractures concluded that more than 60% vertical medial malleolar fractures are with one or more characteristics of medial cortex comminution or with die-punch fragments or with medial joint compression.¹⁷ Patients with die-punch fragment or medial joint compression or large distal tibial articular surface involvement and small fracture line angle (FLA) are positively correlated with the fair to poor results.

They also emphasized that lag screw fixation should be cautiously used in vertical medial malleolar fractures patients with comminuted medial cortex.

Authors came across a few experimental studies, which emphasized that fixation of these fractures with AG plates offered a stable, stiffer fixation, which can tolerate a great amount of axial loading (patient's own body weight) eventually preventing the loss of reduction and fixation in vertical shear fractures of medial malleolus.

Wegner et al found that the AG plate construct was stiffer ($p < 0.05$) than each of the bicortical screw construct ($p < 0.05$) and unicortical screw constructs.¹⁸ The mean stiffness (standard deviation) was 111 (SD=35) N/mm for the parallel unicortical screw construct, 173 (SD=57) N/mm for the divergent unicortical screw construct, 279 (SD=30) N/mm for the bicortical screw construct and 463 (SD=91) N/mm for the AG plate construct. The AG plate construct resisted displacement better ($p < 0.05$) than each of the other three constructs. The mean force for 2 mm of articular displacement was 284 (SD=51) N for the parallel unicortical screw construct, 339 (SD=46) N for the divergent unicortical screw construct, 429 (SD=112) N for the bicortical construct, and 922 (SD=297) N for the AG plate construct. They concluded that an AG plate construct provided the stiffest initial fixation while withstanding higher load to failure for vertical medial malleolus fractures when compared to unicortical and bicortical screw fixation.

Dumigan et al osteotomized eighty polyurethane models of the distal tibia in a reproducible manner to create a vertical shear fracture of the medial malleolus.¹⁹ Twenty specimens then randomly assigned to one of four fixation groups. Two fixation groups used an AG plate, whereas 2 groups were screw-only constructs. Ten of the specimens in each group then randomly assigned to undergo either offset axial or offset transverse loading. They concluded that fixation of vertical fractures of medial malleolus with an AG plate with two screws in the distal fragment exhibited greater stiffness in offset axial loading compared with the screw-only constructs placed an equivalent distance from the tibial plafond. All specimens in the group with the properly applied AG plate exhibited

elastic deformation, whereas the majority of the specimens in all other groups showed residual displacement or catastrophic failure of the construct. They concluded that fixation of vertical shear fractures of the medial malleolus with a properly applied AG plate offers a significant mechanical advantage over screw-only constructs.

Jones et al²⁰ designed a study to evaluate the biomechanical properties of a hook plate (HP) versus AG plate for supination-adduction (SAD) ankle fractures. Identical polyurethane tibial models obtained and vertical fractures created. The fractures were stabilized with one of the following; one-third tubular plate in an AG fashion with two screws proximal to the fracture; an AG plate with an additional screw perpendicular to the vertical shear fragment (MAG) or a HP. Ten models randomly assigned to each of the three groups. The constructs tested in offset-axial loading and evaluated for construct stiffness and load-to-failure. The MAG construct yielded better stiffness compared with the AG plate ($p < 0.05$) and the HP ($p < 0.05$). The plate stiffness of the HP construct compared with the AG was not significant ($p = 0.350$). In regards to load-to-failure, the difference between MAG and AG was 638 N and MAG and HP was 530 N (both $p < 0.05$). The HP had a load-to-failure that was, on average, 108 N more than the AG but was not significant ($p = 0.063$). They concluded that a one-third tubular plate in the MAG fashion provided a stable, strong construct for fixation of vertical shear medial malleolus fractures.

Dajun et al postulated that a number of authors have found that the unicortical cancellous screw, ending in the mid-metaphysis region, lacked secure purchase and increased the risks of fixation failure, especially in vertical fractures and among osteopenia patients. In addition, a 20% non-union rate was reported owing to fixation instability.²¹⁻²³ In their study, the value of displacement in vertical fractures fixed with cancellous screw (CS) was remarkably high, with a failure load (causing 2 mm of displacement) merely at an estimated 346.8 N, which proved that CS were insufficient to withstand shear force in vertical fractures. Another natural defect of screw fixation was the bone-cutting effect, leading to greater risks of loosening or pullout of screws. Stress was mostly concentrated in the proximal plate site, where holes and screws interacted; whereas it was concentrated merely in areas around fractures in CS, which caused a severe bone-cutting effect. Via analyzing the average stress around the screws, they confirmed the bone-protection effect of plate in vertical and oblique fracture. They concluded that the plating was promising in terms of its advantages of improving stability and preventing bone destruction in oblique and vertical medial malleolar fractures.

CONCLUSION

Open reduction and internal fixation with AG plate beyond doubt as it is a stiffer fixation (no loss of fixation

on full weight bearing) preventing the loss of reduction under axial loading (due to patient's own body weight) and at the same time chances of implant failure are remote due to a stiffer construct.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

- Bengnér U, Johnell O, Redlund-Johnell I. Epidemiology of ankle fracture 1950 and 1980. Increasing incidence in elderly women. *Acta Orthop Scand.* 1986;57(1):35-7.
- Court-Brown CM, McBirnie J. Adult Ankle fractures-an increasing problem. *Acta Orthop.* 1998;69(1):43-7.
- Court-Brown CM, Caesar B. Epidemiology of adult fractures: are view. *Injury.* 2006;37(8):691-7.
- Owens BD, Davey S, Zaccilli MA, Belmont PJ. The eepidemiology of ankle sprains in the United States. *J Bone Joint Surg Am.* 2010; 92(13):2279-84.
- Daly PJ, Fitzgerald RH, Melton LJ, Ilstrup DM. Epidemiology of ankle fractures in Rochester, Minnesota. *Acta Orthop Scand.* 1987;58(5):539-44.
- Bugler KE, Clement ND, Duckworth AD, Timothy O, White TO, McQueen MM, et al. Open ankle fractures: who gets them and why? *Arch Orthop Trauma Surg.* 2015;135(3):297-303.
- Hasselmann CT, Vogt MT, Stone KL, Cauley JA, Conti SF. Foot and ankle fractures in elderly white women. Incidence and risk factors. *J Bone Joint Surg Am.* 2003;85(5):820-4.
- Stein EM, Liu XS, Nickolas TL, Cohen A, Thomas V, McMahon DJ, et al. Abnormal microarchitecture and stiffness in postmenopausal women with ankle fractures. *J Clin Endocrinol Metab.* 2011;96(7):2041-8.
- Jensen SL, Andresen BK, Mencke S, Nielsen PT. Epidemiology of ankle fractures: a prospective population-based study of 212 cases in Aalborg, Denmark. *Acta Orthop Scand.* 1998;69(1):48-50.
- Spaine LA, Bollen SR. The bigger they come: the relationship between body mass index and severity of ankle fractures. *Injury.* 1996;27(10):687-9.
- Danis R. The malleolar fractures theory and practice of osteosynthesis. *Theory and Practice of Osteosynthesis.* Paris: Mason; 1949.
- Weber BG. *Die injuries to the upper ankle joint.* Bern: Hans Huber; 1966.
- Surgery reference. Fact sheet: AO Foundation. Available at: <https://www2.aofoundation.org/wps/portal/surgery>. Accessed on 1 October 2021.
- Wang X, Chang SM, Yu GR, Rao ZT. Clinical value of the Ottawa ankle rules for diagnosis of fractures in acute ankle injuries. *Plos One.* 2013;8(4):63228.

15. Lauge-Hansen N. Fractures of the ankle. II. Combined experimental-surgical and experimental-roentgenologic investigations. *Arch Surg.* 1950;60(5):957-85.
16. Zhao H, Zhang Y, Hu D, Liang X, Li Y, Lu J, et al. Comparative study on screw or buttress plate for fixation of supination-adduction type-II medial malleolar fracture. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi.* 2017;31(5):553-8.
17. Zhang J, Zhang Y, Liang J, Liu P, Zhao H. Pathoanatomy and clinical outcomes following operative treatment of supination adduction type II medial malleolus fractures—a cohort study. *Ann Palliat Med.* 2021;10(7):7802-12.
18. Wegner AM, Wolinsky PR, Robbins MA, Garcia TC, Maitra S, Amanatullah DF. Bristol, Avon. 2016;31:29-32.
19. Dumigan RM, Bronson DG, Early JS. *J Orthop Trauma.* 2006 Nov-Dec; 20(10):687-9
20. Jones DA, Cannada LK, Bledsoe JG. *Am J Orthop.* 2016 Mar-Apr;45(3):E98- 102.
21. Ricci WM, Tornetta P, Borrelli J. Lag screw fixation of medial malleolar fractures: a biomechanical, radiographic, and clinical comparison of unicortical partially threaded lag screws and bicortical fully threaded lag screws. *J Orthop Trauma.* 2012;26(2012):602-6.
22. King CM, McCobb DR, Collman PM, Lagaay JD. Bicortical fixation of medial malleolar fractures: are view of 23 cases at risk for complicated bone healing. *J Foot Ankle Surg.* 2012;51:39-44.
23. Fowler TT, Pugh KJ, Litsky AS, Taylor BC, French BG. Medial malleolar fractures: a biomechanical study of fixation techniques. *Orthopedics.* 2011;34:349-55.

Cite this article as: Aora KK, Kapila R, Chaudhary P, Singh R, Kapila S. Efficacy of antiglide plate in vertical shear fractures of medial malleolus due to supination adduction injury around ankle: a prospective clinical study. *Int Surg J* 2021;8:3626-33.